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Parameters of Reward for Mongolian Gerbils (Meriones unguiculatus)

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PARAMETERS OF REWARD FOR MONGOLIAN GERBILS

(*Meriones unguiculatus*)

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ABSTRACT

This experimental investigation was designed to test which of four rewards would elicit the fastest and most consistent running speeds from Mongolian gerbils (Meriones unguiculatus). The four rewards were: Purina Lab Chow, .045 grams Noyes Precision Pellets, Sunflower seeds, and Hamster feed. Twenty-four male gerbils (90-120 days old) were randomly assigned to a deprivation group (D) and trained in a straight alley runway under a restricted ration deprivation schedule for 70 acquisition and 35 extinction trials. A second group of 24 subjects (non deprived group, ND) were similarly trained while on a free feed schedule.

Each group was further divided into four sub-groups differentiated on the basis of type of reward. The sub-groups were divided into two squads with Squad 2 starting acquisition trials the day following the last extinction trial of Squad 1.

A multi-factor analysis of variance was computed for acquisition and extinction training. The results indicate a significant deprivation and trials effect ($p < .05$) and a not significant reward effect ($p > .05$).

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CHAPTER I

INTRODUCTION

The use of animals in the laboratory has been very beneficial in many types of research. The most common subjects used in psychology laboratories are the white rat and the college sophomore (Lewis, 1963 p. 126). One reason animals are used is because they are small and many can be kept readily available in the lab. Another reason is that although many man-hours of maintenance are required for feeding, filling water bottles and cleaning of the cages, the animals do not normally require special diets or preferential treatment. A third reason animals are used is due to the nature of certain types of experimentation which would be highly unethical to perform on a human being.

Although the rat is the most commonly used animal, a new animal has been used more and more frequently, i.e., the Mongolian gerbil (Meriones unguiculatus). The gerbil is larger than a mouse but smaller than a rat. In the limited amount of research conducted using gerbils, they have been found to be comparable to the white rat.

Since motivation of some type is necessary to encourage responding, and since food deprivation is the most common in animal research studies, this study was designed to show what type of food reward for deprivation elicits the most consistent responding.

Brief History of the Gerbil

The Mongolian Gerbil was first mentioned in a research paper by Tanimoto in 1943 (Nauman 1963). The adult male may reach a weight of 100 grams or slightly over, but usually averages between 80 and 90 grams

A gerbil is a small, bright-eyed rodent, similar in appearance and coloring to the Golden Hampster. They have the pert expression of a chipmunk, the jerky movements of a squirrel and the ease of care credited to the hampster (Socolof 1966).

Gerbils originated from the desert regions and sandy wastes of Asia, Africa and southern Russia (Socolof 1966), and the dry sandy areas of Mongolia, northern Korea and the Necca Province of China (Nauman 1963).

The gerbils are members of the order Rodentia, the family Cricetidae, and the sub-family Gerbillinae.

Meriones is one of ten genera classified under Gerbilliane. They are called gerbils because of their jerboa-like (nocturnal jumping rodent, having long hind legs, long tail and being mostly yellowish brown with white underparts and black tipped tail) appearance and actions, and sometimes, they are referred to as sand rats, desert rats or jird. Meriones unguiculatus may sometimes be designated as the clawed jird (Schwentker 1963).

Milne-Edwards described and classified the species in 1867 (Tanimoto 1943, cited in Nauman 1963). Tanimoto and Chaworth-Musters and Ellerman (1947, both cited in Nauman 1963) provided body and skeletal measurements as well as detailed set of differentiating and descriptive measurements.

Gerbils are small and docile and can be easily handled since they do not normally bite or struggle excessively. The animal is clean, practically odorless, breeds readily in captivity and can be maintained under a wide range of conditions. Because the gerbil is small, it has meager food requirements and excretes minute quantities of urine and dry fecal pellets and, therefore, is easily maintained in any size laboratory.

Although gerbils when in the wild, live in large colonies in underground burrows, they readily adopt to group living cages with wood chips covering the floor. The wood chips absorb the urine and allow the gerbil to dig and build a nest and scratch about.

Gerbils will eat almost any kind of grass seeds and various grains, especially wheat and barley, if they are available (Nauman 1963). Also gerbils will grow healthy on the same laboratory chow fed to other animals in the laboratory. Experiences in the lab have shown that the gerbil will crack and eat the meat of sunflower seeds, stopping all other behavior when a few seeds are dropped into their cage.

Although gerbils have been used in many studies in medical research (Rich 1968) there are relatively few studies in behavioral research, where they have been used as subjects.

The Problem

Statement of the problem. This experiment was conducted to determine which of four types of food reward (lab chow, Noyes pellets, sunflower seeds, or hamster feed) would elicit the fastest and most consistant rate of responding. These groupings are shown in Figure 1.

Figure 1. The factors of the experiment

Reward / Deprivation	Noyes Pellets	Lab Chow	Sunflower Seeds	Hamster Feed
No deprivation				
Deprivation				

Need for the study. The gerbil is being used more and more frequently in behavioral research and food deprivation is one of the most common procedures for motivating the animal. Before the effectiveness of the deprivation can be assessed, a reward or reinforcement must be found that will highly motivate the animal to learn a task. If a suitable reward can be found for the gerbil, the feasibility of using gerbils in a laboratory situation in place of the white rat can be assessed.

Limitations and Delimitation. Experimentation was limited to forty-eight gerbils purchased from a commercial source. The gerbils were 90 to 120 days old at the start of the experiment which lasted for 60 days. The experiment is further limited to four rewards: Lab Chow, .045 Noyes Precision Pellets, Sunflower seeds and Hamster feed.

The temperature (and the humidity) of the lab could not be adequately controlled and ranged from 68 to 78 degrees F. (The humidity was not measured.)

Outside noises and interruptions were held to a minimum, but could not be completely eliminated due to the need of others to use the lab.

<u>Definitions of Terms</u>

<u>Ad Lib</u>. Ad lib shall mean free feeding.

<u>Analysis of variance</u>. Analysis of variance will be abbreviated <u>Anova</u>.

<u>Gerbil</u>. Gerbil shall refer to Mongolian gerbil (*Meriones unguiculatus*).

<u>Goal time</u>. Goal time will be from the second photo cell inside the goal box to the food cup (final 10-inches).

<u>Reward</u>. Reward shall be lab chow (<u>LC</u>), .045 gram Noyes pellets (<u>NP</u>), sunflower seeds (SS), or hamster feed (<u>HF</u>).

<u>Run time</u>. Run time will be the time from the first photo cell to the guillotine door at the entrance to the goal box (middle 48-inches).

<u>S</u>. Subject will be abbreviated <u>S</u>.

<u>Start time</u>. Start time will be the time from the opening of the start box door until the <u>S</u> crosses the first photo cell (first 15-inches).

<u>Total time</u>. Total time will be the sum of the start, run and goal times.

Organization of the Remainder of the Thesis

The remainder of the main body of this thesis will consist of five chapters, Chapters II through VI.

Chapter II will be devoted to a review of relevant research on deprivation, runway studies and studies using gerbils.

The methodology used in this experimental study will be explained in Chapter III. Chapters IV, V and VI will consist of a thorough explanation of the results and conclusions, discussion, conclusions and summary and Chapter VII will give the recommendations.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Introduction

Behavioral researchers are constantly trying to find Ss for experimental research. Because of ethical problems involved in certain types of experimentation on human subjects, lower animals are used. But problems arise here too, because lower animals are different from humans. Researchers are trying to find the link between humans and lower animals. The monkey, chimpanzee, and ape fall in this interval, but because of their size they require a rather large laboratory space and much maintenance.

So experimenters have used smaller animals because their requirements of space and maintenance are less than those of the previously mentioned animals. These smaller animals include the guinea pig, hamster, mouse, pigeon and rat, as well as other small animals.

Recently a new animal has been introduced as a S in research, the gerbil. Nauman (1963), Rich (1968), and Schwentker (1963), give a good account of research using the gerbil in both medical and to a much lesser extent,

behavioral research. Glickman and Hartz (1964) studied the locomotor exploratory behavior of seven species of rodents and indicated that the rat was the better S, because it was not as curious as the others, yet bold enough not to hide as some of the other animals did, instead of exploring the open field.

Schwentker (1963) suggested that because of the extremely powerful curiousity drive of the gerbil, conditioning of a food-reinforced response might be difficult or impossible. However, Campbell, Straney and Neuringer (1969) successfully conditioned gerbils to press the bar in a Skinner box under 3 different schedules of reinforcement; 1:1 Fixed ratio, 15 sec. Variable interval and 60 sec. Variable interval. The results indicated that periods of relatively rapid responding were sometimes followed by periods during which the gerbils groomed and explored.

Nauman (1963) also conditioned gerbils to bar pressing in a Skinner box. In the same experiment, Nauman used a discrimination runway, which is similar to a straight alley runway except that a partition divides one end of the runway into two parts, with each part

containing a food well. The gerbils learned in 1 or 2 trials to find the reward in the well at the top of the stimulus object. An additional four to eight trials were usually required for the gerbil to learn to take the reward from one side then go to the other side for the reward there.

Both Campbell, Straney and Neuringer (1969) and Nauman (1963) used a food-reinforced response and found that the gerbil could be conditioned without excessive difficulty.

Studies on Motivation and Deprivation

Motivation of a S to respond in an experimental situation can be achieved in several ways. Probably the most well known is food deprivation.

Cohen and Stetner (1969) found that 24-hour water deprived animals learned faster and made fewer mistakes than those not deprived.

Miles (1965) and Goodreich (1966) stated that deprivation plays a very important role in learning and that deprivation generally results in an increase of behavior designated as exploration and an increase in activity.

They also found that the length of deprivation facilitates the response of the animal.

Snapper, Schoenfield, Ferraro and Locke (1966) found that 80 per cent ad lib deprivation caused a larger number of responses per minute, when compared with a group that was at 65 per cent of starting weight.

Eisman (1956) compared three deprivation lengths (4, 22, and 46-hour deprivation) and found the 46 hour deprived group of rats learned a black and white discrimination better and faster than either of the other two groups.

Even though there are some studies indicating that exploration and increased activity will take place even without deprivation (Berlyne 1960, Dashiell 1925, and others) most authors will agree that deprivation will increase the activity level of the S. Alderstein and Fehrer (1955) pointed out that the apparatus used with animals that had an increase in activity offered more "copious and varied stimulation than those in which the opposite effect appeared" (p. 253).

Taylor (1970) found that if immature animals are used, systematic restriction of access to food for a time

period or reduction to a percentage of body weight is best.

Ramond, Carlton and McAllister (1955) used three groups of rats of different deprivation percentages and found that white male rats at 75 to 80 per cent of _ad lib_ weight achieved higher acquisition levels and at higher rates than similar groups at weights greater than 80 per cent of _ad lib_ weight. Treichler and Homic (1966) found no significant difference in activity between groups weighing 75 per cent of _ad lib_ weight and those weighing 95 per cent of _ad lib_ weight. They also found that limited feeding schedules were faster and easier to control than limited time schedules. This has also been confirmed by Spence (1956), Berlyne (1960), Dashiell (1925), Alderstein and Fehrer (1955), and others (Cicala 1961, Campbell and Cicala 1962).

A problem with deprivation is how long the _Ss_ should be on a deprivation schedule before starting the experiment. Capaldi and Robinson (1960) investigated this problem. Using two groups of rats on the same deprivation schedule, but for different lengths of time, they found faster instrumental responses and fewer errors in the

longer deprived group. Ramond, Carlton and McAllister (1955) using three equally deprived groups of rats found adjustments to the schedule not to be complete until thirty days after beginning the schedule.

There are several ways deprivation can be achieved. One way is to limit the amount the animal eats in a 24-hour period. Another is limit the amount of time the animal can eat in a 24-hour period. Laboratory experience, and other published data, has shown that the latter way can be a more severe method and less stable than the former, if too short a time period is allowed.

Ramond, Carlton and McAllister (1955) used two groups of rats (equal in males and females) placing one group on a limited time (LT) schedule and the other on a limited amount (LA) schedule. The LT group was given 25 grams of lab chow and allowed to eat for 50 minutes. The LA group was given 8 grams of lab chow and no time limit. Both groups were tested in a modified Skinner box. The results indicated that the LT group lost less mean body weight than did the LA group (significant difference for males) and also retained significantly higher mean percentages of their original body weight. The LA - LT

difference was significantly larger for the males than for the females in both the absolute and percentage of body weight measures. The LT males ate significantly more per day than did the LT females.

During the 72 food-reinforced speed trials under 22-hour deprivation, the LA males ran significantly faster than did the LT males, but there was no significant difference between the LA females and LT females. The LA males ran faster than the LA females, but the LT males ran slower than the LT females.

Reynierse, Scavio and Ulness (1969) assessed gerbil runway performance under hunger motivation and found that the 22-hour group was superior to either the 6 or 12-hour deprived groups which did not differ from each other. A second experiment was run and the same results were found. Then a third experiment was reported in which a daily ration technique of feeding the animal was used. The amount of food eaten in each 24-hour period was measured and recorded for 12 days while the Ss were on ad lib feed. When the experiment started each S was fed either 30 per cent or 50 per cent of the mean ad lib food intake and remained on that schedule until the end of the experiment.

The 30 per cent group ran significantly faster in both acquisition and extinction. The conclusion drawn from the three experiments was that the food rationing technique produced more uniform and stable results and that the food rationing technique yielded a greater motivational control than the food deprivation techniques of the first two experiments and "is the preferred procedure" (p. 37).

Finger (1957) found that activity was higher and acquisition faster when the time between response and reward decreased.

Studies on the magnitude of reward. Although deprivation plays an important part in motivating an animal to respond, the amount of reward given as reinforcement also effects responding.

Fox, Calef, Gavelek and McHose (1970) working with a double alley runway, reported that running speed to large reward decreases in the second alley as the magnitude of reward received in the first alley increases.

Using 50 per cent, 75 per cent and 100 per cent levels of reinforcement, Hill, Cotton and Clayton (1962) found that rate of acquisition was a direct function of per cent

of reward. A similar conclusion was reached after a replication of this study by DeAmato, Schiff and Jacoda (1962).

Kintsch (1960) studying the role of magnitude of reward found that drive strength increased as the magnitude of reward increased.

A relatively large magnitude of reward (4 seeds per response as opposed to 1 seed per response) was found by Gossette and Hood (1968) to facilitate overall discrimination performance in pigeons.

Studies by Hooper (1967), North (1950), Pubals (1957), Schrier and Harlow (1956) and Feldman (1969) of discrimination in rats support the idea that large magnitudes of reward facilitates discrimination.

Schrier and Harlow (1956) also found that correct discrimination was a function of magnitude of rewards, if each S, during the course of learning, was reinforced with all levels of reward.

Other related studies. The open field behavior of the gerbil and the rat was compared by Nauman (1968). An open field 3.5 feet square was divided into 49, 6 x 6 inch squares. The squares were grouped into three groups:

inside 18.4 per cent (middle 9 squares), intermediate 32.6 per cent (16 squares outside the middle 9 squares) and the outside 49 per cent (outer row of squares - 24). The rat spent 86 per cent of the total observation time in the outside perimeter, 5 per cent in the intermediate 33 per cent and 9 per cent in the inside set of squares while the gerbil spent 37 per cent in the outside, 28 per cent in the intermediate and 35 per cent in the inside. The total distance traveled per minute was 396 inches for the gerbil and 190 inches for the rat. The results indicate the gerbil is much more active, curious and exhibits more exploration than the rat. The conclusion drawn was that gerbils would behave quite differently than a rat in a maze.

Thiessen, Lindzey, Blum, Tucker and Friend (1968) tested the visual behavior of the gerbil. They conducted three experiments, the first of which was on the visual cliff. Gerbils were compared to mice and the results showed that 65 per cent of the mice responded to the shallow side on all 10 trials whereas only 4 per cent of the gerbils did.

In the second experiment, the preference for darkness was tested. Both the gerbils and mice showed a preference for the dark side, with 70 per cent of the 20 minutes spent on the dark side.

In the third experiment, Circadian Activity was measured. Pairs of gerbils were observed in running wheels under the usual 12 hour light and the 12 hour dark cycle and after a reversal of the light cycle. Results indicated a strong nocturnal activity with a clear peak around 1:30 a.m. "The gerbil is obviously sensitive to differences in light intensity and makes appropriate behavioral adjustments" (p. 23).

Boice, Boice and Dunham (1968) compared gerbils, kangaroo rats and laboratory mice in a shuttlebox and their reactivity to shock and avoidance. The gerbil and kangaroo rats were similar in their nonreactivity to the grid shock, however, the gerbils avoided at a markedly higher level than the kangaroo rat and both avoided less than the mice.

Summary

In each of the studies cited, deprivation was used to motivate the animal to respond. The type of reinforcement

was generally lab chow. As was pointed out by Schwentker (1963) and Campbell, Straney and Neuringer (1963), food-reinforcers were perhaps a weak reinforcer. Although the desired behavior was achieved, there was some question as to the effectiveness of the reward.

Campbell, Straney and Neuringer (1963) suggest "By systematically varying deprivation and reinforcement, future experiments can explore these hypotheses" (p. 256).

In the chapters to follow, one such attempt at finding a strong food reinforcer will be thoroughly examined.

CHAPTER III

METHODOLOGY

Subjects

Forty-eight gerbils, 90 to 120 days old, purchased from a commercial source, were randomly assigned to 8 equal groups of 6 subjects (Ss). The Ss were experimentally naive and individually housed.

Apparatus

The apparatus consisted of a 75-1/2 x 5 x 4 inches wide grey alley runway with a 10-1/2 inch start box, a 48 inch runway, and a 16 inch goal box, separated by 1/2 inch wooden guillotine doors. A 1-1/2 x 2-1/2 x 1 inch metal cup, placed at the end of the goal box contained the food reward.

Response speeds were measured by standard interval timers, graduated .01 second, which were operated by electrical relays connected to a microswitch, activated by opening the start door, and three photo-electric cells located from the beginning of the start box: 15 inches (start time), 62-3/4 inches (run time), and 73 inches (goal time). Response speeds were recorded on a tape

recorder and transcribed to a response sheet.

The rewards used were: 1) .045 grams Noyes Pellets, 2) crumbled Purina Lab Chow, 3) Sunflower seeds and 4) Hamster food with sunflower seed and pellets removed. One and one-half grams of reward were placed in the food cup for each S before the start of trial 1 and removed after trial 5.

Procedure

The Ss were randomly assigned to either the deprivation or the no-deprivation group and to one of the four reward conditions. Each group was then divided in half and put into two squads. Squal 1 started on Day 1 with ad lib feeding procedure and Squad 2 started on Day 21 with ad lib feeding procedure. The sequence of events are shown in Table 1. The Ss were given 12 days of ad lib food and water, during which time each S's food intake was recorded daily by subtracting the remaining food weight from the amount fed 24 hours previously. On Days 13 to 26, the Ss were placed on a 30 per cent restricted ration (30 per cent of the mean ad lib food intake).

Table 1. Days and functions of the experiment.

Days	Squad	Function
1-12	1	*Ad lib* feeding schedule
7-9	1	3-min. exploration
10-12	1	1-min. feed
13-26	1	Acquisition (5 trials per *S*)
22-33	2	*Ad lib* feeding schedule
27-33	1	Extinction (5 trials per *S*)
28-30	2	3-min. exploration
31-33	2	1-min. feed
33	1	Squad 1 completed
34-47	2	Acquisition (5 trials per *S*)
48-54	2	Extinction (5 trials per *S*)
54	2	Squad 2 completed

On Days 7 to 9, the Ss were allowed to explore the runway, but without feed in the food cup for three minutes each day. On Days 10 to 12, the Ss were placed in the closed goal box and fed in the food cup the reward they would receive in acquisition trials and allowed to eat for 60 seconds.

On Days 13 to 26 (acquisition), each S received runway training of five massed trials. On each trial the start box door was raised and then closed as soon as the S entered the runway. The trial was terminated when the S remained in the goal box for 60 seconds or had eaten. When the S had eaten for 20 seconds, the S was replaced in the start box and the next trial was begun. After the fifth trial, the S was returned to its home cage and fed its daily ration 30 minutes later.

On Days 27 to 33 (extinction), runway procedure identical to the previous 14 days was used except that the food reward was omitted.

The acquisition training consisted of 5 trials a day for 14 days for a total of 70 acquisition trials and the extinction period consisted of 5 trials a day for 7 days for a total of 35 extinction trials.

CHAPTER IV

RESULTS AND CONCLUSIONS

General - Acquisition

A 2 (deprived vs. non deprived) x 4 (parameters of reward) x 14 analysis of variance with repeated measures (Ss) was computed for start, run, goal and total times (Winer 1962). In all cases there were significant deprivation and trials effects ($p < .05$). These results indicate that deprivation does produce a state of motivation for the gerbil and that running speed decreased over trials.

These results support previously cited experiments by Nauman; Campbell, Straney and Neuringer; and Feynierse, Scavio and Ulness in that gerbils could learn tasks for food reward and performance would improve over trials.

The F values were not significant ($p > .05$) for reward, and for the deprivation-reward interaction.

The reward-trials interaction was significant ($p < .05$) for start, run and total times. The interactions are shown in Figures 2, 3 and 4. The reward-trials interaction was not significant for goal time. These results indicate a significant difference in the effect

Figure 2. Reward-trials interaction for acquisition start-time.

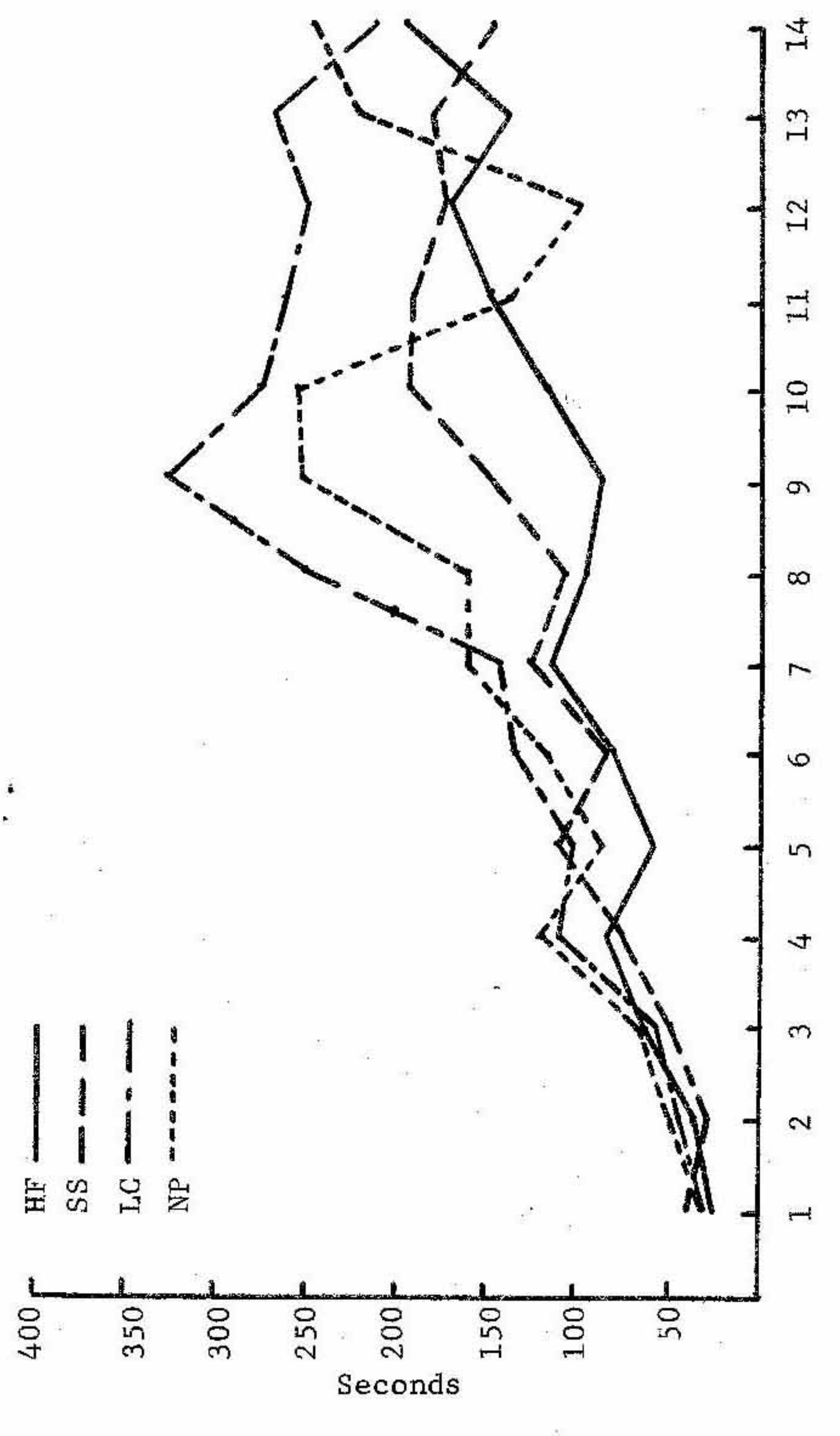


Figure 3. Reward-trials interaction for acquisition run time.

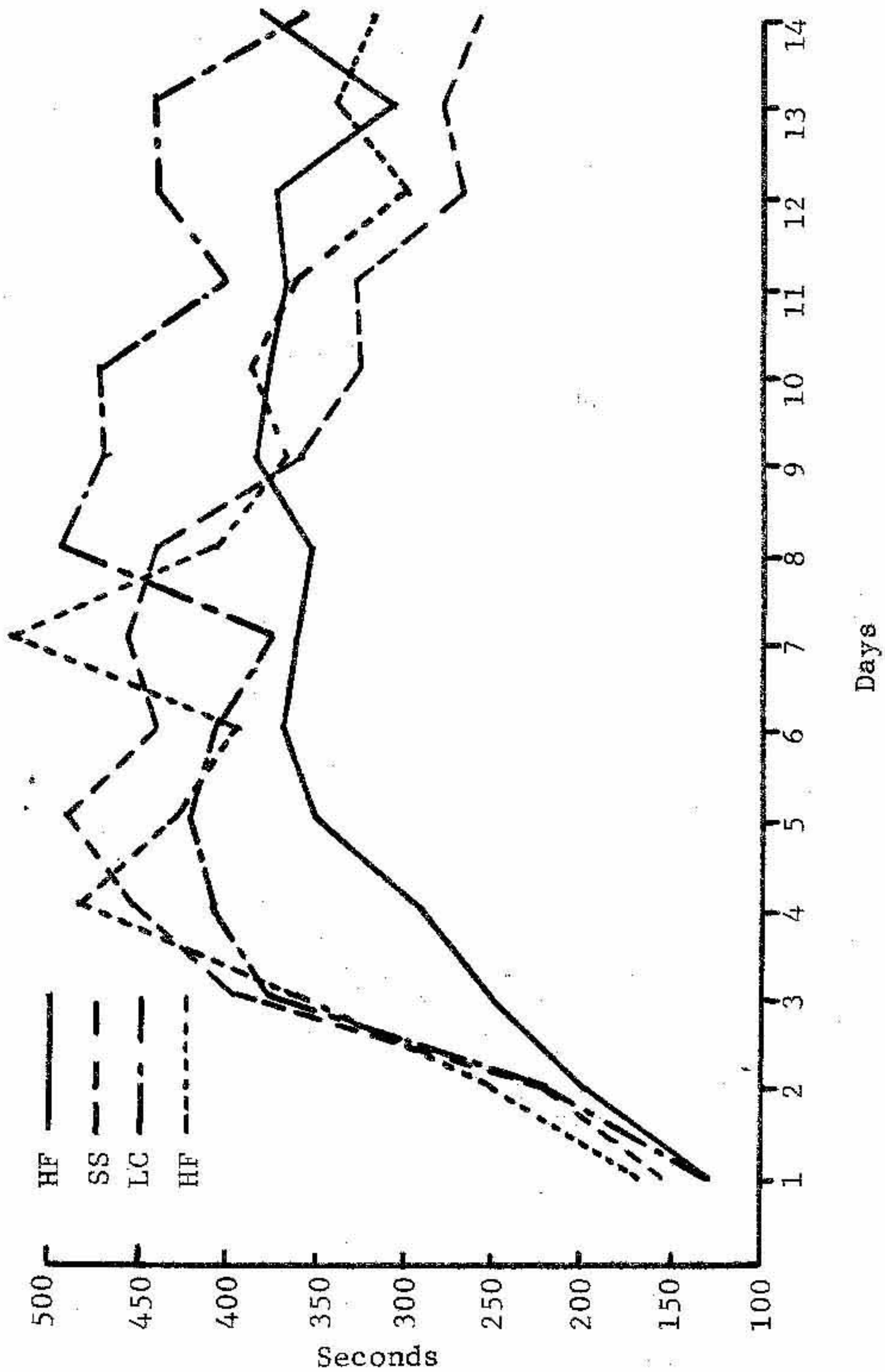
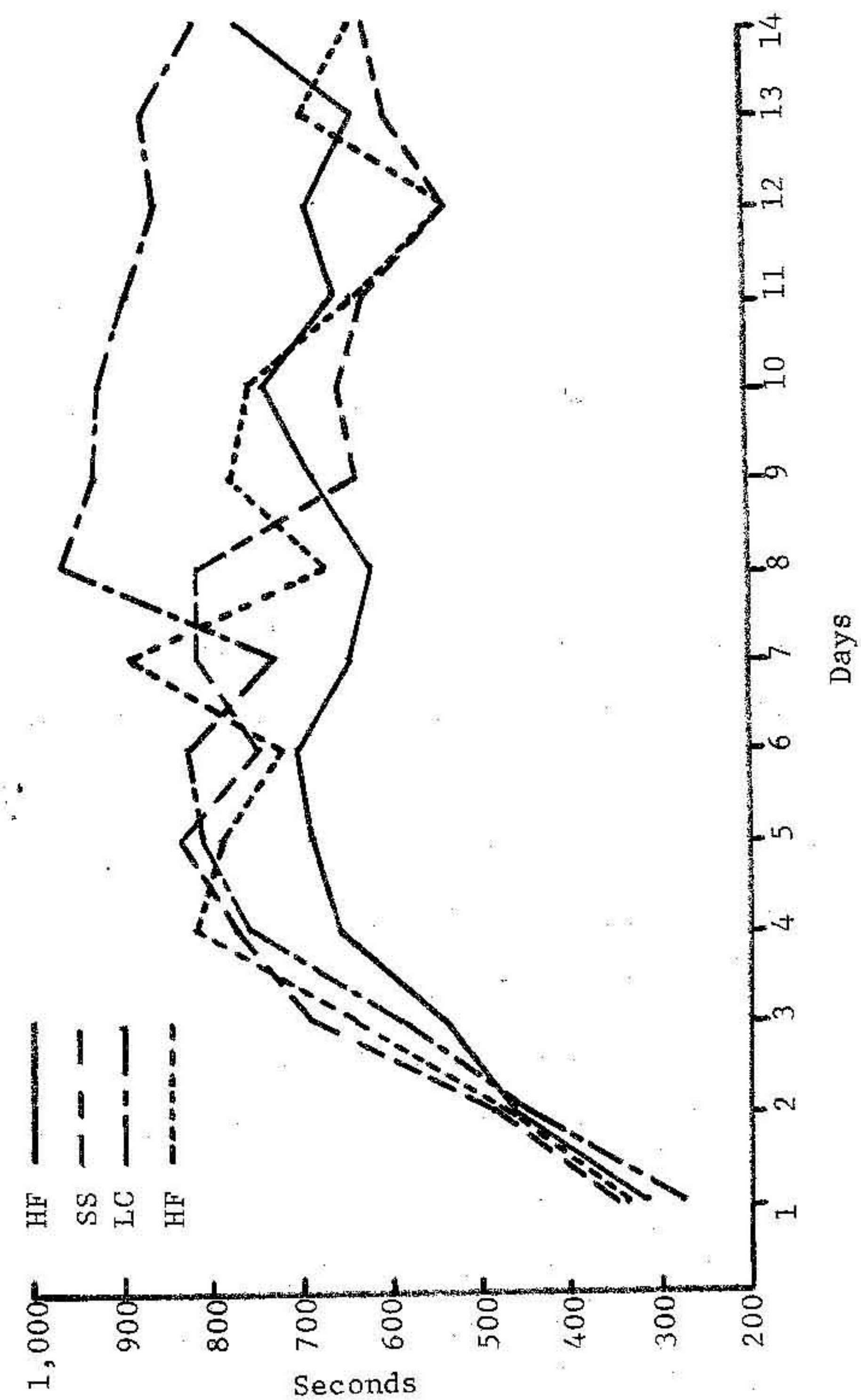


Figure 4. Reward-trials interaction for acquisition total time.



of the types of reward over different days of trials.

In acquisition start time there was a significant difference in deprivation (_A_), trials (_C_), deprivation-trials interaction (_AC_) and reward-trials interaction (_BC_) effects, but no significant difference in reward (_B_), deprivation-reward interaction (_AB_) or the deprivation-reward-trials interaction (_ABC_) effect (all values at p= .05).

In acquisition run time, there was a significant deprivation, trials, deprivation-trials interaction and reward-trials interaction effect and not significant difference in rewards, deprivation-rewards interaction, or deprivation-rewards-trials interaction. In acquisition goal time, there was a significant effect due to deprivation, trials, deprivation-trials interaction, but not significant effect due to reward, deprivation-rewards interaction, rewards-trials interaction, or deprivation-rewards-trials interaction. In acquisition total time, there was a significant effect due to deprivation, trials, deprivation-trials interaction, and reward-trials interaction, but no significant difference in rewards, deprivation-rewards interaction, or deprivation-rewards-trials interaction.

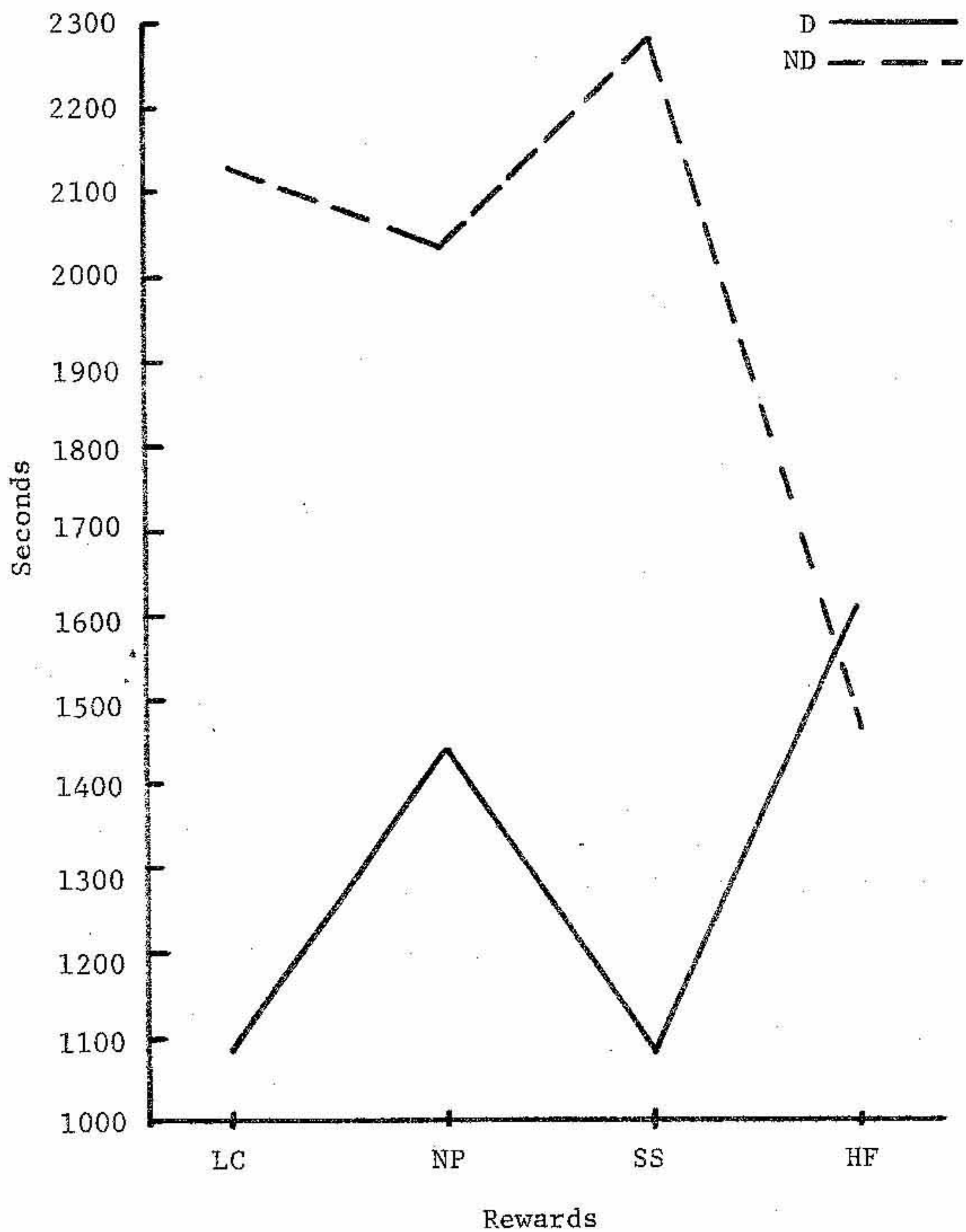
General - Extinction

A 2 x 4 x 7 analysis of variance with repeated measures (Ss) was computed for start, run, goal and total times. In all cases, there were significant deprivation and trials effects ($p < .05$). These results indicate that there is a significant difference in running speeds between deprived and non deprived Ss and that running speed does increase over trials in extinction.

The F values for reward were not significant ($p > .05$) and the F values for the reward-deprivation interaction were not significant except for the extinction run time. The reward-deprivation interaction for extinction run time was significant and is shown in Figure 5. This indicates a significant difference in the effect of the types of reward on the two deprivation conditions.

In extinction start time there was a significant difference in deprivation and trials and no significant difference in rewards, deprivation-reward interaction, deprivation-trials interaction, rewards-trials interaction, or deprivation-rewards-trials interaction. In run time, there was a significant difference in deprivation, deprivation-rewards interaction, trials, and deprivation-

Figure 5. Deprivation-reward interaction for extinction run time.



trials interaction, but no significant difference in rewards, rewards-trials interaction, or deprivation-rewards-trials interaction. In goal time, there was a significant difference due to deprivation and trials, but no significant difference due to rewards, deprivation-rewards interaction, deprivation-trials interaction, rewards-trials interaction, or deprivation-rewards-trials interaction. In total time, there was a significant effect due to deprivation, trials and deprivation-trials interaction, but no significant difference due to rewards, deprivation-rewards interaction, rewards-trials interaction, or deprivation-rewards-trials interaction.

All *F* values for the P x Q x R with repeated measures *ANOVA* can be found in Table 2.

Additional ANOVA

The nature of the raw data upon observation indicated that there was a possible confounding of the data due to divergence of the running speed between the deprived and non deprived groups. So, a second *ANOVA* was computed using only the data for the deprived group.

For acquisition, a 4 x 14 analysis of variance with repeated measures (*Ss*) was computed. The *F* values for

Table 2. Table of F values for the P x Q x R w/repeated measures ANOVA.

Time - Acquisition

	Effect	F value	df/p=.05	significant
Start				
	A	9.30	1,40/4.08	yes
	B	1.50	3,40/2.84	no
	AB	0.57	3,40/2.84	no
	C	16.13	13,520/1.75	yes
	AC	8.04	13,520/1.75	yes
	BC	1.48	39,520/1.40	yes
	ABC	0.97	39,520/1.40	no
Run				
	A	15.38	1,40/4.08	yes
	B	0.47	3,40/2.84	no
	AB	1.27	3,40/2.84	yes
	C	14.70	13,520/1.75	yes
	AC	12.52	13,520/1.75	yes
	BC	1.50	39,520/1.40	yes
	ABC	0.75	39,520/1.40	no
Goal				
	A	23.66	1,40/4.08	yes
	B	0.38	3,40/2.84	no
	AB	0.96	3,40/2.84	no
	C	4.40	13,520/1.75	yes
	AC	3.97	13,520/1.75	yes
	BC	0.74	39,520/1.40	no
	ABC	0.98	39,520/1.40	no
Total				
	A	40.96	1,40/4.08	yes
	B	1.06	3,40/2.84	no
	AB	1.97	3,40/2.84	no
	C	15.14	13,520/1.75	yes
	AC	21.02	13,520/1.75	yes
	BC	1.57	39,520/1.40	yes
	ABC	1.10	39,520/1.40	no

(Table 2, continued)

Time - Extinction

	Effect	F value	df/p=.05	significant
Start				
	A	14.05	1,40/4.08	yes
	B	0.57	3,40/2.84	no
	AB	1.18	3,40/2.84	no
	C	3.50	6,240/2.14	yes
	AC	0.78	6,240/2.14	no
	BC	1.58	18,240/1.68	no
	ABC	1.05	18,240/1.68	no
Run				
	A	16.13	1,40/4.08	yes
	B	0.27	3,40/2.84	no
	AB	3.20	3,40/2.84	yes
	C	6.52	6,240/2.14	yes
	AC	4.37	6,240/2.14	yes
	BC	0.84	18,240/1.68	no
	ABC	0.77	18,240/1.68	no
Goal				
	A	21.86	1,40/4.08	yes
	B	0.17	3,40/2.84	no
	AB	0.25	3,40/2.84	no
	C	3.04	6,240/2.14	yes
	AC	0.60	6,240/2.14	no
	BC	0.79	18,240/1.68	no
	ABC	1.30	18,240/1.68	no
Total				
	A	48.83	1,40/4.08	yes
	B	0.65	3,40/2.84	no
	AB	2.65	3,40/2.84	no
	C	13.99	6,240/2.14	yes
	AC	3.39	6,240/2.14	yes
	BC	1.06	18,240/1.68	no
	ABC	1.05	18,240/1.68	no

reward and reward-days interactions were not significant ($p > .05$) and the *F* values for trials were significant ($p < .05$).

In acquisition start time there was a significant difference due to trials (*B*) but no significant difference due to reward (*A*) or the reward-trials interaction (*AB*). In run time, goal time, and total time the results were the same, *B* was significant ($p < .05$) and *A* and *AB* were not significant ($p > .05$).

In extinction a 4 x 7 *ANOVA* with repeated measures (*Ss*) was computed. All *F* values for the trials effect were significant, as in acquisition. All *F* values for reward and for reward-trials interaction (except start time) were not significant. The extinction start time reward-trials interaction was significant. This indicates a significant difference in the effect of types of reward on days of trials and is shown in Figure 6. All *F* values for the P x Q *ANOVA* with repeated measures can be found in Table 3.

The results of this experiment indicate no significant difference between the rewards. In several cases, however, type of reward was found to have an effect on

Figure 6. Reward-trials interaction for extinction start time (P x Q).

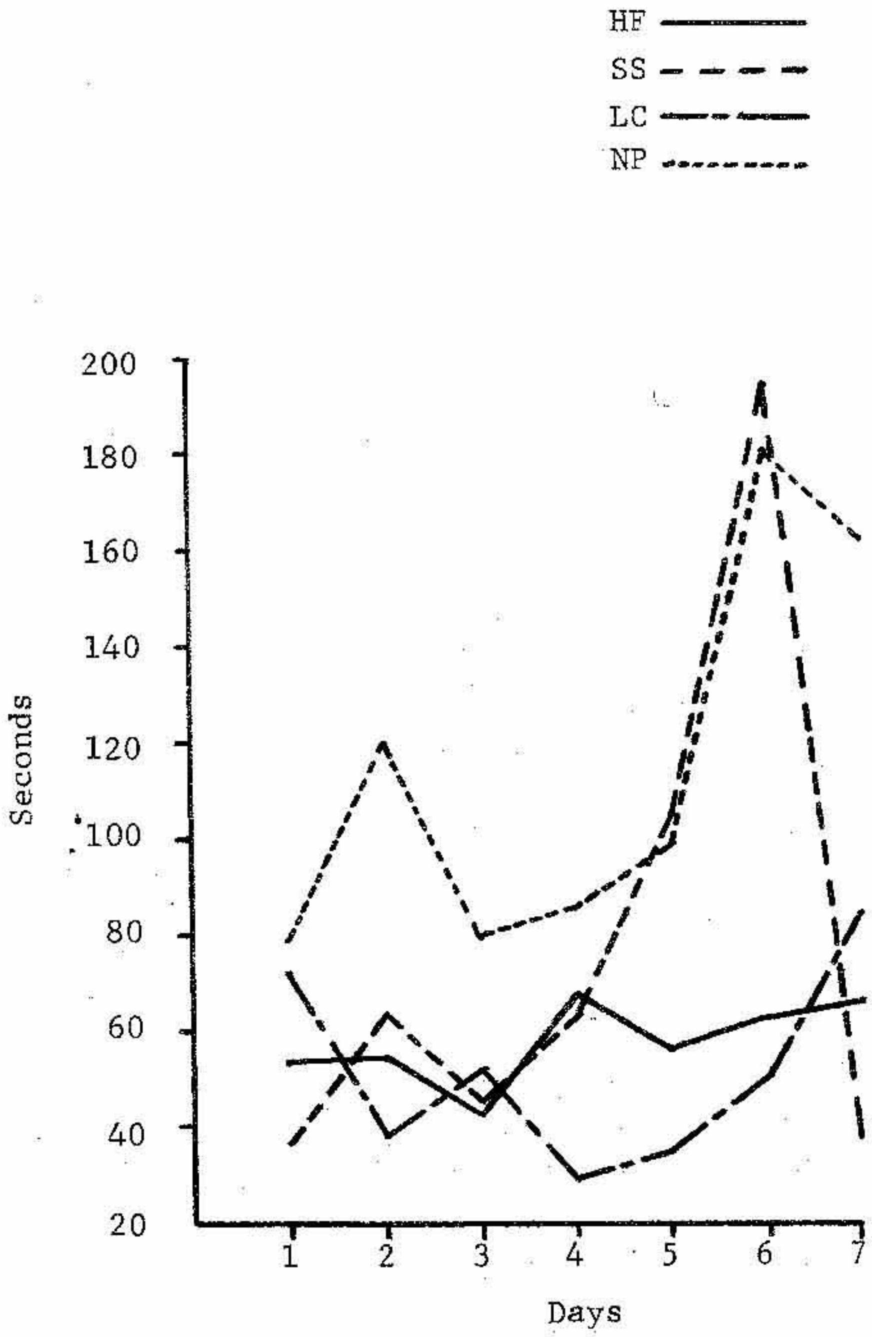


Table 3. Table of F values for the P x Q ANOVA w/repeated measures

Time - Acquisition

	Effect	F value	df/p=.05	significant
Start				
	A	0.66	3,20/8.66	no
	B	4.68	13,260/1.77	yes
	AB	1.29	39,260/1.47	no
Run				
	A	0.52	3,20/8.66	no
	B	9.89	13,260/1.77	yes
	AB	0.93	39,260/1.47	no
Goal				
	A	2.86	3,20/8.66	no
	B	8.18	13,260/1.77	yes
	AB	1.18	39,260/1.47	no
Total				
	A	0.40	3,20/8.66	no
	B	11.81	13,260/1.77	yes
	AB	1.20	39,260/1.47	no

Time - Extinction

	Effect	F value	df/p=.05	significant
Start				
	A	6.38	3,20/8.66	no
	B	5.89	6,120/2.17	yes
	AB	2.98	18,120/1.70	yes
Run				
	A	1.24	3,20/8.66	no
	B	7.20	6,120/2.17	yes
	AB	0.51	18,120/1.70	no

(Table 3 continued)

Time - Extinction

	Effect	F value	df/p=.05	significant
Goal				
	A	0.55	3,20/8.66	no
	B	3.96	6,120/2.17	yes
	AB	0.91	18,120/1.70	no
Total				
	A	1.23	3,20/8.66	no
	B	14.97	6,120/2.17	yes
	AB	0.87	18,120/1.70	no

the two deprivation conditions and on different trials. This indicates that even though there is no significant difference between rewards, there is a significant difference in the effects of the different types of reward on deprivation and over trials.

Additional support for the statistical analysis of the data can be found on the graphs of each group for total time (see Appendix I). The mean time for the group rewarded with sunflower seeds was lower than that for any other group.

Because of the statistical analysis of the data and the supporting evidence of the graphs for the groups and some considerations discussed in Chapter V, sunflower seeds would be the preferred choice for a food reward for gerbils.

CHAPTER V

DISCUSSION

Statistical Analysis

In all 16 ANOVAs computed for this experiment the main effect of reward was not significant. Also most of the interactions were not significantly different at $p=.05$. The graphs for total time indicate that the group rewarded with sunflower seeds had the fastest mean total time of all groups. One possible explanation for the lack of significant difference could be in the fact that the error term in each ANOVA was very large. This would indicate a large amount of individual differences and consequently a smaller *F* value.

The main effect of reward was not significant in any case, but five of the interactions involving reward were significant. This indicates that the types of reward did have an effect on this experiment. Type of reward had an effect on trials as well as level of deprivation. The reward-trials interaction was significant in extinction run time (see Figure 2). The significant interaction in acquisition run time (reward-trials) and in extinction run time (deprivation-reward) is indicative of the strength of sunflower seeds as a reward. The Ss

were generally quick to leave the start box and, once restricted to the goal box, generally quick to go to the food cup. This was true with the deprived group and to a lesser extent the non deprived group. Also, the area of the start and goal box was restrictive to movement. The runway section allowed the Ss greater freedom for activity and exploration, and therefore, running speed in this section would be more indicative of the effectiveness of the reward.

The fastest running subjects were in the deprived group rewarded with sunflower seeds. But, because of two other subjects, that ran slow, the overall average for the group was slower. However, the subjects in the deprived-sunflower seed group did run faster as a group than any of the other groups.

Non Statistical Analysis

In determining which reward to use, there are several factors which should be considered: availability, cost, storage and retention of reward properties. The first factor considered will be availability.

In most all research labs, a food similar to lab chow is used for daily maintenance of rats and gerbils.

Therefore, it would be readily available for use. Noyes Precision pellets are also frequently used in the lab as a food reward in an operant conditioning box for small animals (rat, mouse, gerbil and other similar animals) so, it also, would be readily available in most labs. Sunflower seeds and Hamster food on the other hand are less commonly used in the lab so a supplier would have to be found. Raw sunflower seeds can be bought in most seed stores and Hamster food is sold in most pet stores.

The second factor to consider is cost. Lab chow generally sells for 12 cents a pound. Noyes Precision pellets are sold in a container by number of pellets rather than weight and generally cost $10 to $15 a pound. Sunflower seeds can be bought at a cost of 6 or 7 cents a pound. Hamster food can be bought in a one pound box for around 40 cents. On the basis of cost, sunflower seeds are the most economical of the four rewards costing only half as much as lab chow and much less than the other two rewards.

Storage is the third factor to consider. Lab chow and Noyes Precision pellets should be stored in a dry

area and used up rather quickly to avoid the growth of grain bugs, which take approximately two to two-and-one-half months to mature from the larva. Noyes pellets will dry out and lose part of their greenish color if stored for several months. Sunflower seeds and Hamster food do not require a dry area nor do they seem to contain anything similar to a grain bug. All four of the foods should be kept out of wet places.

The final factor to consider is the retention of the reward properties of the different foods. As mentioned previously, the Noyes pellet loses color during storage. In this stage, it also appears to be drier as it crumbles to powder easier than when fresh. Lab chow is similar to the Noyes pellet as it also loses color and can be crumbled easier after being opened and stored for a short time. On the other hand, sunflower seeds and Hamster food (which is composed of several types of whole grain) do not change color when stored.

When the four factors previously discussed are considered together, the sunflower seeds rate better than the other three rewards. Sunflower seeds are as available as the other three rewards, but costs only half as

much as lab chow and much less than Noyes pellets or Hamster food. They are as easily, if not easier, stored than any of the other rewards, except perhaps Hamster food. Sunflower seeds retain most, if not all, of their reward properties, as does Hamster food. Both of which retain their reward value better than lab chow or Noyes pellets.

Even though there was no significant difference between the main effects of the four rewards in the ANOVA, the fact that there were significant reward interaction with deprivation and trials in both acquisition and extinction indicates the difference in the effect of the different rewards on trials and on levels of deprivation. Also the fact that the group rewarded with sunflower seeds did have the fastest mean total time in acquisition and the factors discussed in the previous paragraph, all indicate that sunflower seeds are the preferred of the four rewards.

Methodological Considerations

There are some problems involved with this experiment. One S went into convulsive seizures upon being placed in the home cage after trials on five different days and during training on two other days when placed in the

start box. These seizures lasted only a few minutes and afterwards the *S* appeared to be breathing more rapidly than usual. On the two days of training, the *S* was allowed five minutes to rest before the next trial was started. The performance of the *S* on the following trial or day after a seizure, did not appear to be unusually different.

One *S* was found dead on the sixth day of extinction and the mean running time for the previous day was used for the remaining two days for the computation of the *ANOVA*. The *S* did not appear to be sick or unusually active the day preceeding its death, but was nearing 65 per cent of the *ad lib* starting weight. Possibly, the deprivation schedule was too strict or else an error was made in determining the mean *ad lib* food intake. Such an error was not found in double checking the data.

The deprivation schedule also caused some problems because the deprived group was running at approximately the same speed as the non deprived group for the first four days of acquisition. On the fifth day, the deprived group began running faster, a trend that continued until

the end of the acquisition training.

The figures for total time (Appendix I) for this experiment would indicate that the deprivation should be started four or five days in advance of the start of acquisition trials. Thus, the Ss would be more highly motivated at the start of acquisition instead of on the fourth day. Also, the Ss may require a longer ad lib feeding schedule for a more accurate determination of the mean ad lib food intake.

The 30 per cent food rationing technique worked for 40 of the 48 Ss. Of the remaining 8, the schedule was too severe on 5 who lost weight rapidly until they reached 75 per cent of starting weight, at which time weight loss slowed down. The remaining 3 lost weight more slowly and, after 21 days of deprivation, were weighing around 85 per cent of starting weight.

When acquisition training started, the Ss were allowed a total of 180 seconds to traverse the length of the runway. If they had not reached the goal box in that time, they were replaced in the start box and the next trial started. This procedure caused problems because some Ss would stay in the runway and time would

run out. The _S_ would have a start time and then the remainder of the 180 seconds would be time in the runway and there would be no goal time. Thus, a problem on the computation of the _ANOVA_ arose because there was no goal time. This problem was corrected by allowing the _S_ only 60 seconds in each segment of the runway and then placing them in the next section. On the trials that had been completed, the _S_ was given 60 seconds as run time and 60 seconds for goal time if the time had expired with the _S_ in the runway. Since _Ss_ in each group had had the same problem, the effects of the correction were spread relatively equal over all groups.

CHAPTER VI

CONCLUSIONS AND SUMMARY

The conclusions inferred from this experiment are that gerbils can be trained using food deprivation as motivation and food as a reward. The results showed a significant effect due to deprivation and trials ($p < .05$) and no significant difference between rewards.

The results further showed several significant deprivation-reward and reward-trials interactions. A comparison of the figures (Appendix I) for total time for all subjects shows that the group rewarded with sunflower seeds had the fastest mean running time. The statistical findings and the other factors discussed above (figures, availability, cost, storage and retention of reward values), all indicate that sunflower seeds are the preferred reward.

The results indicate that deprivation will effect the motivation of the gerbil. The deprived gerbil ran significantly faster ($p < .05$) than the non deprived S. A significant trials effect indicated that performance improved over trials in acquisition and decreased over trials in extinction which is what would be expected.

The 30 per cent food rationing technique of deprivation worked effectively for this experiment for most Ss but there were some exceptions as noted previously. The length of the ad lib feeding schedule was possibly too short to make an accurate determination of the mean ad lib food intake and then starting deprivation the same day as acquisition, the Ss were not motivated to run until the fourth day when running speed began to decrease until the end of acquisition.

CHAPTER VII

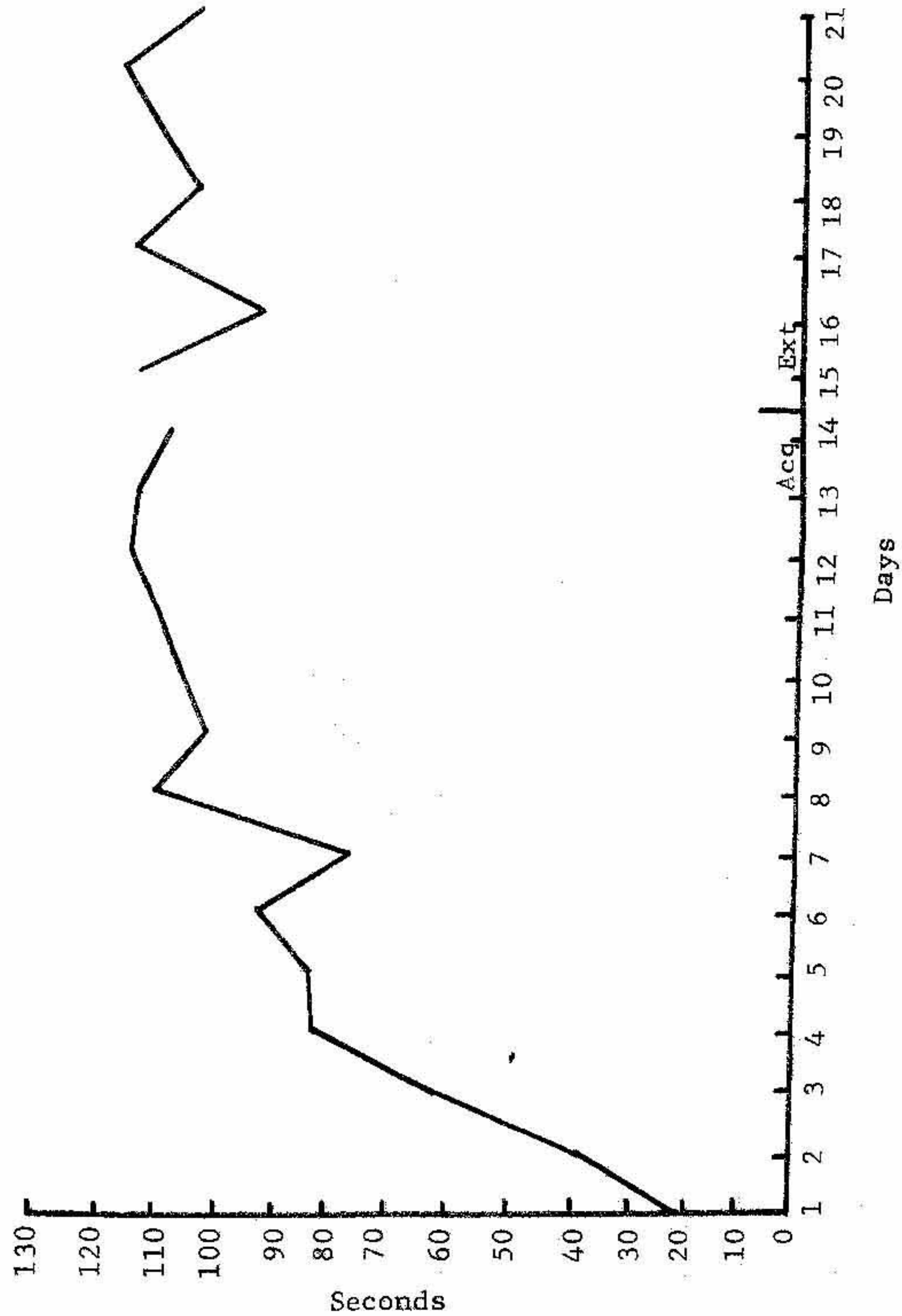
RECOMMENDATIONS

In light of the results of this experiment, food deprivation is recommended as a means of motivating gerbils to respond. Although the results did not show conclusively that sunflower seeds were the best reward, the significant reward interactions with deprivation and trials imply that sunflower seeds are better reinforcers than the other three rewards, when using deprivation techniques, and is the preferred reward. This recommendation is further substantiated by the comparisons of the figures in the Appendix and by the other factors considered, especially cost and retention of reward properties in which the sunflower seeds appeared better than the other three rewards. An additional recommendation is that the 30 per cent food rationing technique be used in further research to determine if additional days of measuring _ad lib_ food intake would give a more reliable estimate of this deprivation procedure. Also, deprivation should be started four or five days before the start of acquisition training to insure the _Ss_ are motivated on the first day of acquisition.

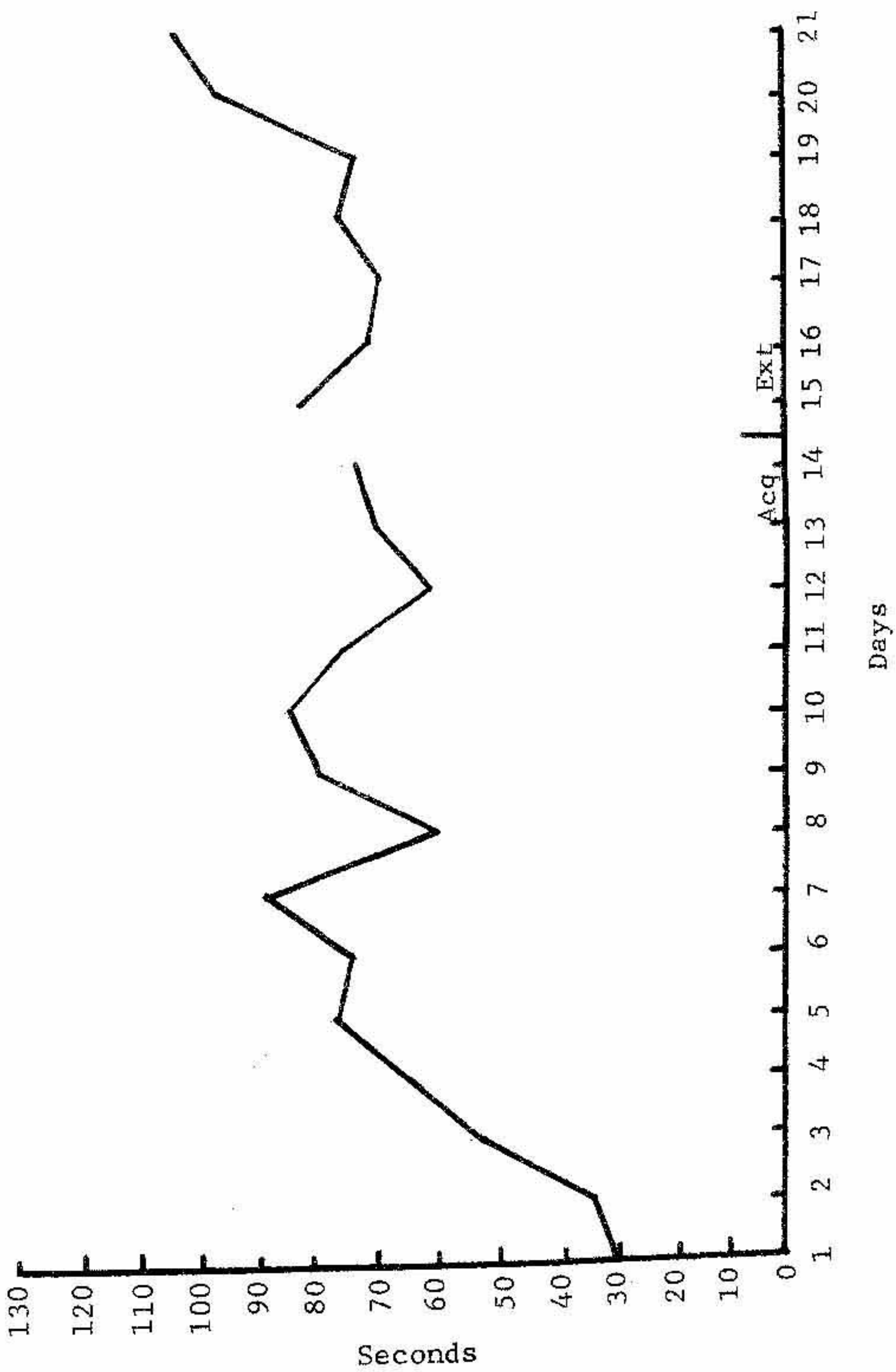
APPENDIX

APPENDIX I

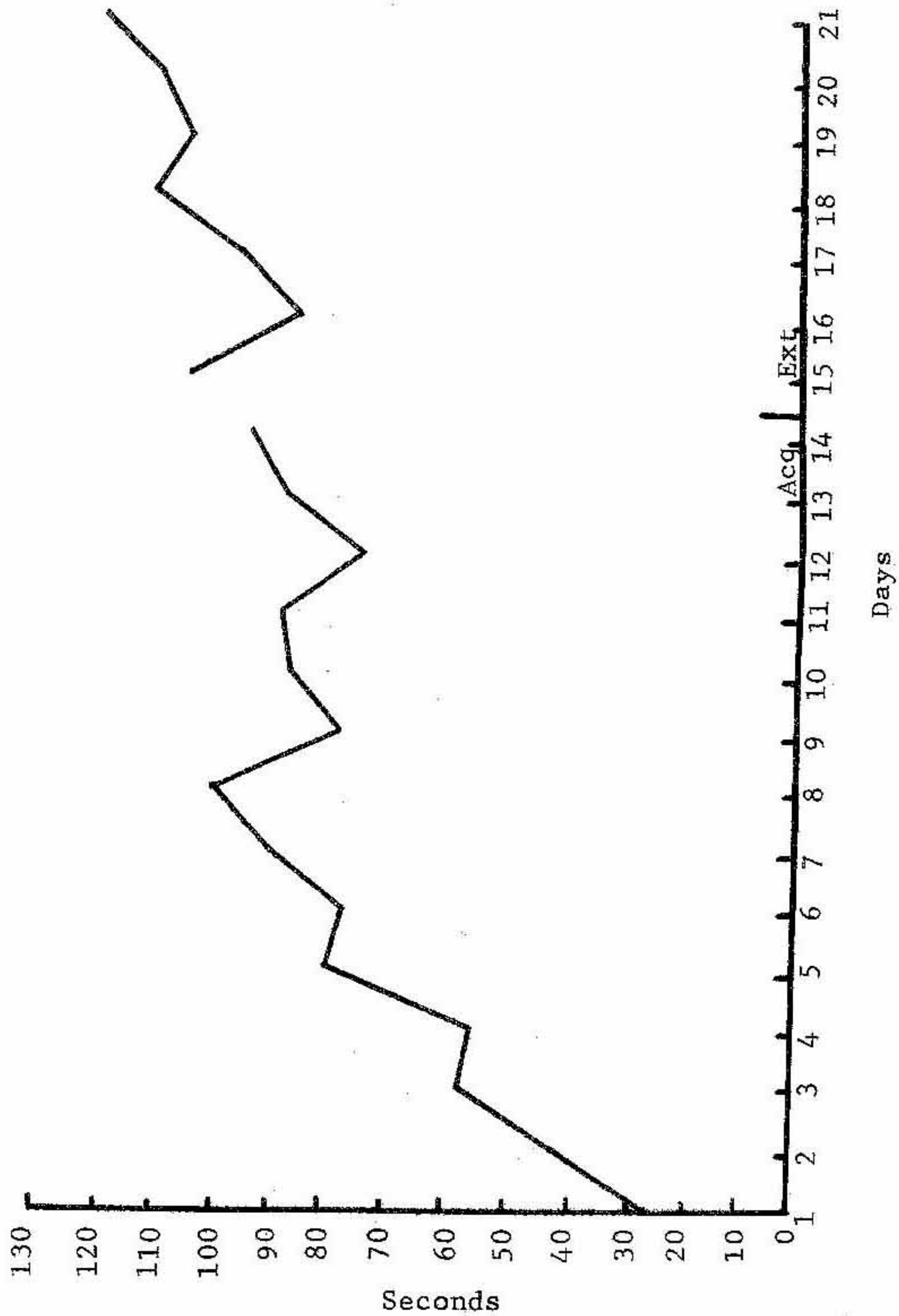
Total time for Non deprived - Lab Chow group



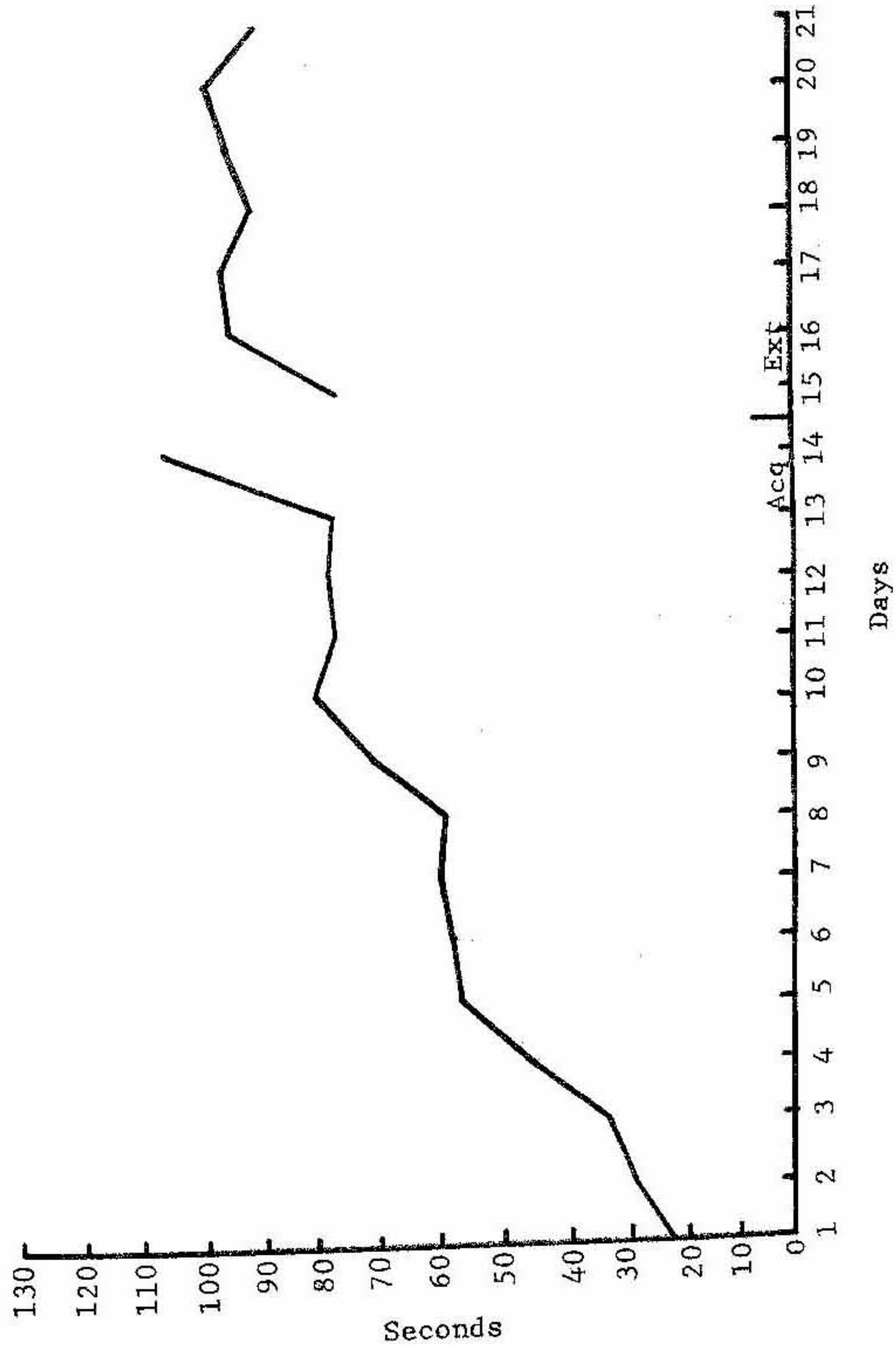
Total time for Non deprived - Noyes Pellet group



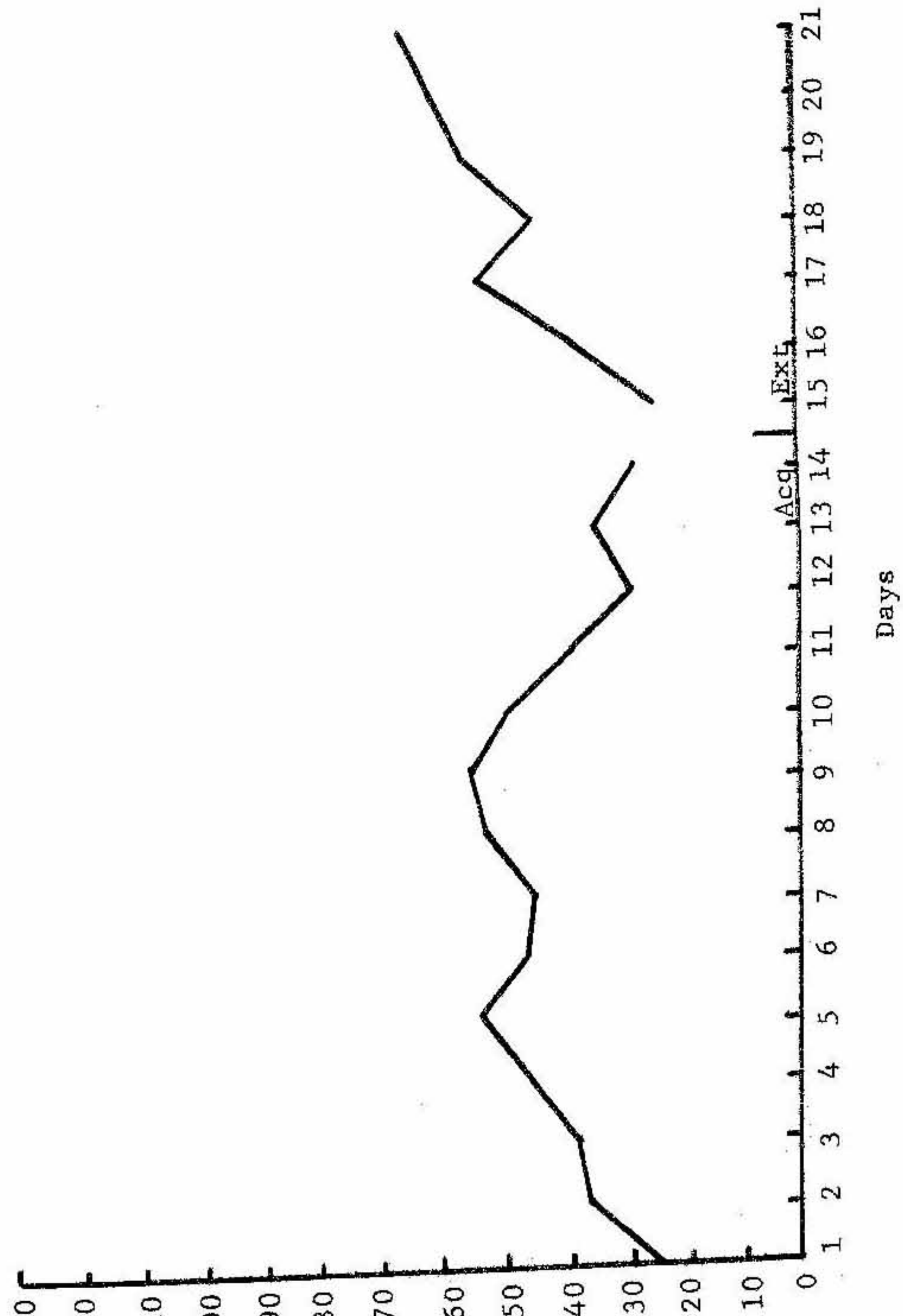
Total time for Non deprived - Sunflower seed group



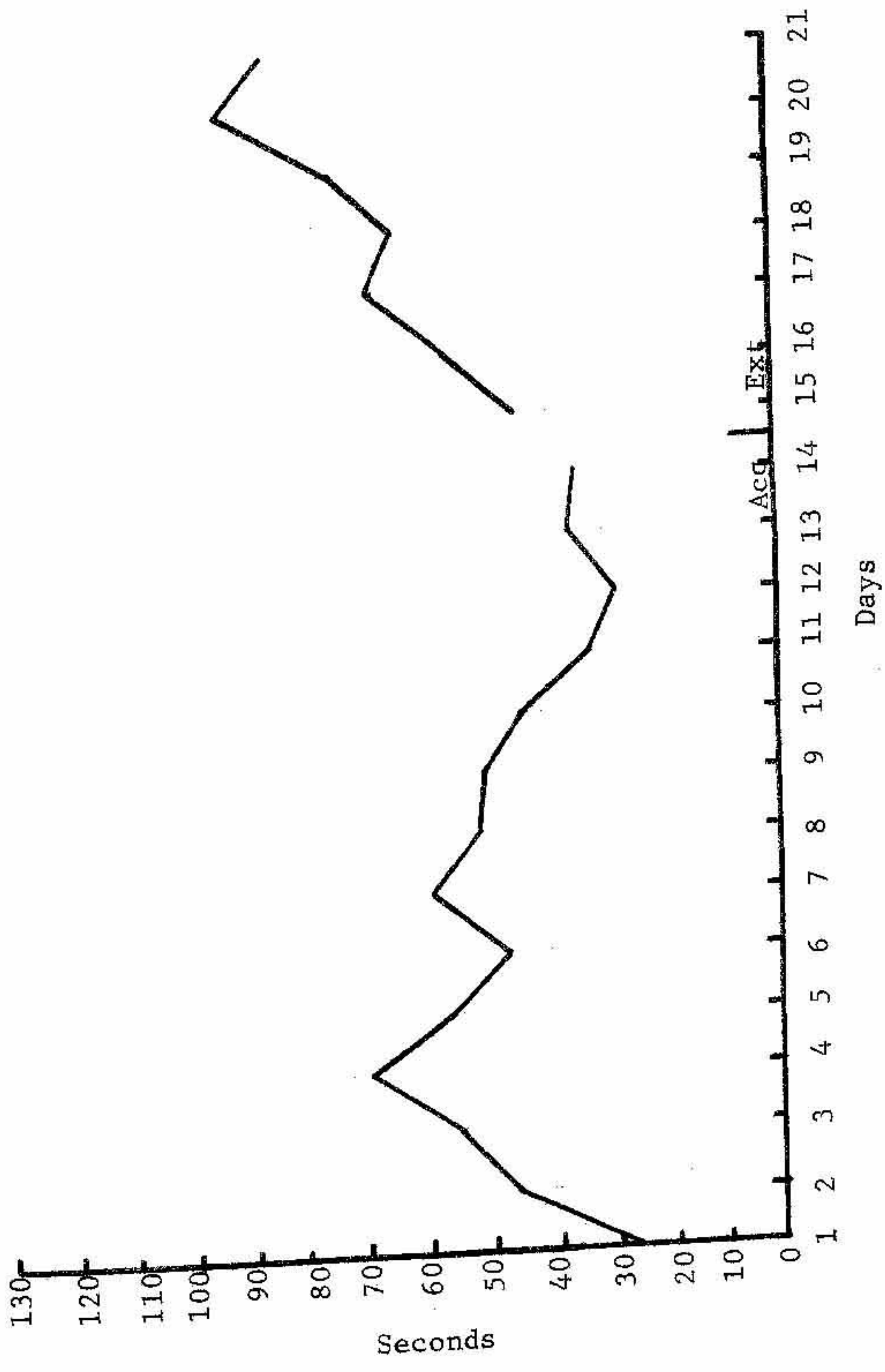
Total time for Non deprived - Hamster food group



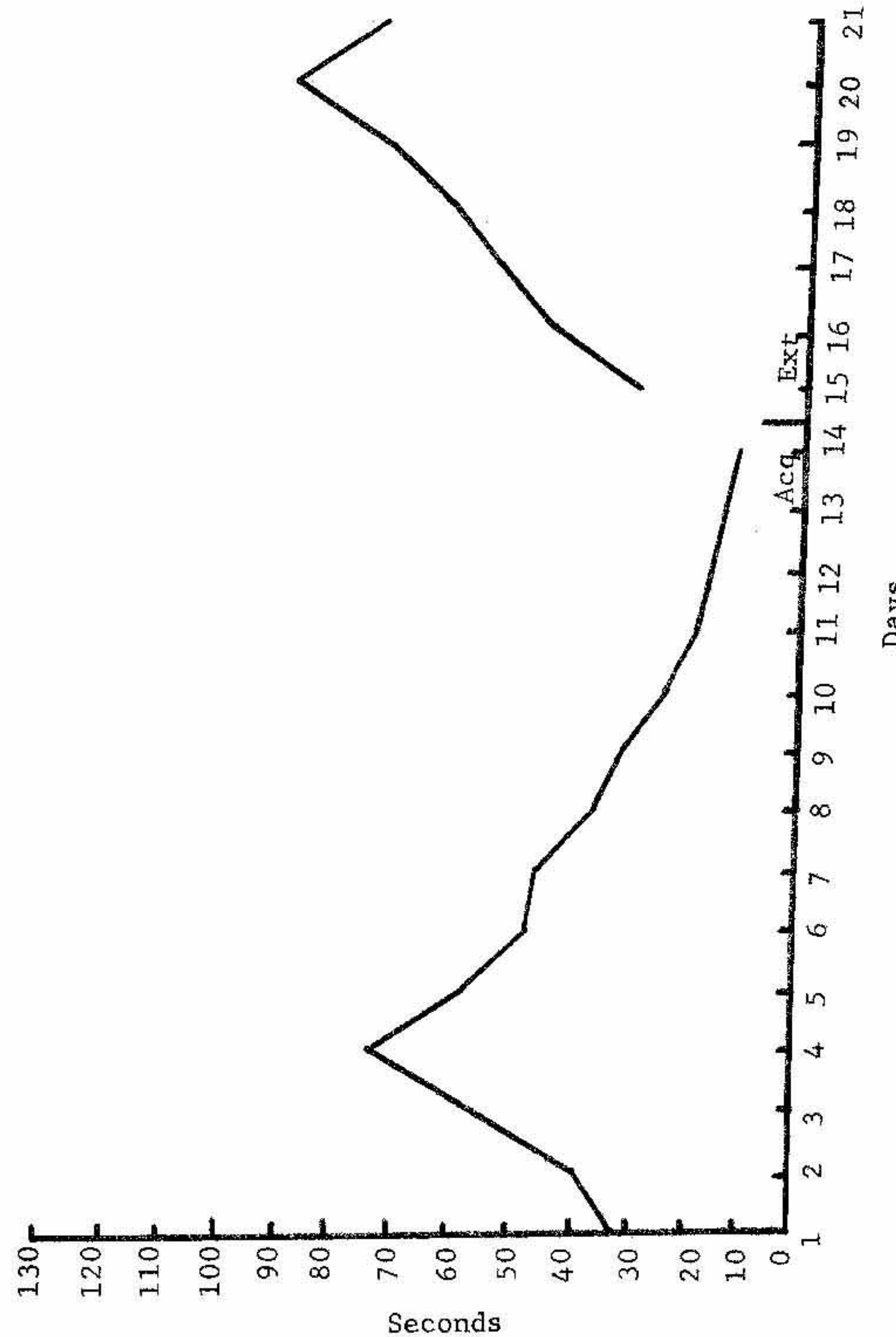
Total time for Deprived - Lab Chow group



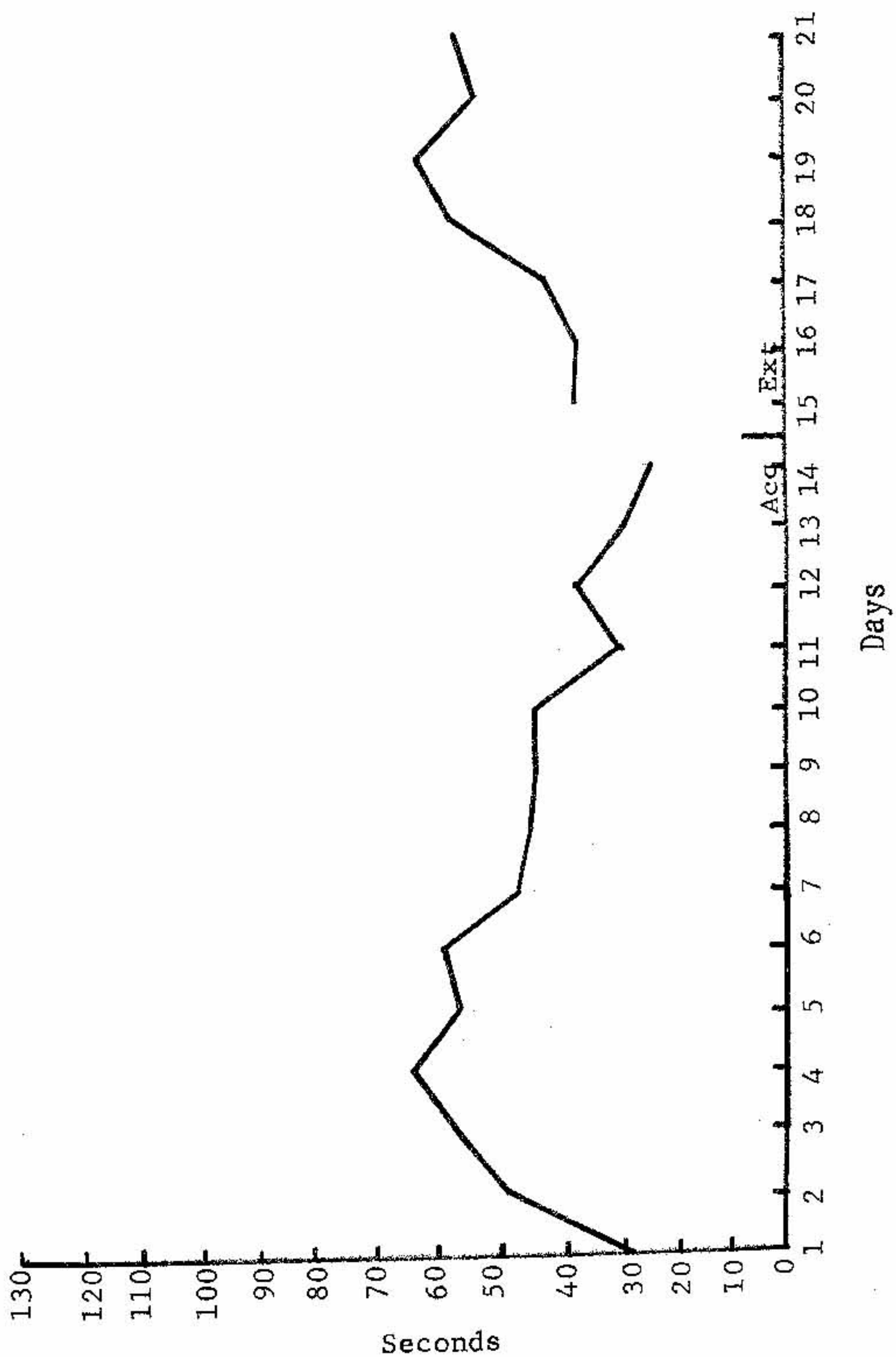
Total time for Deprived - Noyes Pellet group



Total time for Deprived - Sunflower seed group



Total time for Deprived - Hamster food group



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